Final

East Lake Sammamish Master Plan Trail Surface Water and Water Quality Discipline Report

Prepared for

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ACRONYMS

AKART	all known, available, and reasonable methods of treatment
BMPs	best management practices
CIP	capital improvement project
CMP	corrugated metal pipe
CWA	Clean Water Act
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EIA	effective impervious surface
EIS	Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map(s)
GIS	geographic information system
HPA	hydraulic project approval
IMC	Issaquah Municipal Code
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
PAA	potential annexation area
PGIS	pollutant-generating impervious surface
RCW	Revised Code of Washington
RM	River Mile
ROW	right of way
SCCP	spill containment and countermeasures plan
SEPA	State Environmental Policy Act
SWPPP	surface water pollution prevention plan
TESC	temporary sediment and erosion control
TMDLs	total maximum daily loads
UGB	urban growth boundary
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

This discipline report summarizes existing streams, floodplains, man-made drainage systems, and water quality for the East Lake Sammamish Master Plan Trail project area, estimates the potential water-quality impacts and the benefits of each project alternative in the East Lake Sammamish Master Plan Trail Environmental Impact Statement (EIS), and documents methodology and assumptions used to develop these estimates. This report also provides a summary of measures proposed to mitigate potential water-quality impacts and summarizes compliance of the proposed alternatives with surface-water-related plans and policies.

1.1 OVERVIEW OF AFFECTED ENVIRONMENT

The project is located in Water Resource Inventory Area (WRIA) 8: Cedar-Sammamish Basin and includes four major watersheds: Bear Creek, Sammamish River, East Lake Sammamish, and Issaquah Creek (Figures 1-A, 1-B, and 1-C, Project Location Maps). These are described in Section 5 Affected Environment. These watersheds include numerous smaller basins and subbasins drained by perennial and intermittent streams, seeps, wetlands, and man-made drainage systems. In general, these watersheds are located in areas of commercial and residential development and the natural hydrologic regime and water quality have been altered. Appendix A Project Corridor Subbasin Maps provides subbasin maps for the project area. Appendix B Project Corridor Stream and Culvert Table provides a table of streams and culverts in the project area.

1.2 PROJECT PURPOSE AND NEED

The King County Department of Executive Services Facilities Management Division (FMD) proposes to develop a multi-use[1] trail (a non-motorized transportation corridor) along 10.6 miles of former Burlington Northern/Santa Fe (BNSF) railroad corridor on the east side of Lake Sammamish. The proposed East Lake Sammamish Master Plan trail would extend from Gilman Boulevard in the city of Issaquah north to 200 feet west of Bear Creek in the city of Redmond. The trail would provide access to recreation, employment, and retail centers in the cities of Redmond, Sammamish, and Issaquah and complete a link in the regional trails system. The trail is intended to safely accommodate a variety of user groups such as bicyclists, pedestrians, runners, wheelchair users (including those with motorized wheelchairs), in-line skaters, and equestrians, and different ages and skill levels within those groups.

1.3 SUMMARY OF MAJOR WATER QUALITY CONCERNS

Within the project corridor, the Washington State Department of Ecology (Ecology) has identified the following water bodies: the North Fork of Issaquah Creek, Laughing Jacobs Creek, Pine Lake Creek, Ebright Creek, George Davis Creek, Lake Sammamish, Sammamish River, and Bear Creek, in the Category 5 polluted waters/303(d) List of Threatened and Impaired Waterbodies.[2] A summary of the water bodies and the specific pollutants that are associated with them are shown in Table 1-1 Summary of Category 5 Polluted Waters within the Project Area.

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[1] A multi-use trail is synonymous with a “shared-use path or trail” as defined by the American Association of State Highway and Transportation Officials (AASHTO), “a multi-purpose trail” as defined in the King County Regional Trails Plan, and a “Class 1 bikeway” as defined in WSDOT’s Facilities for Non-Motorized Transportation.
[2] Ecology is currently in the process of finalizing this list.

In addition, King County has identified Lake Sammamish as "sensitive" (sensitive lakes are particularly sensitive to phosphorus) and has documented water quality problems in Lake Sammamish related to phosphorus loading. Bear Creek has been designated a "regionally significant stream" that requires special best management practices (BMPs) for water-quality treatment and higher standards for stormwater runoff detention (see Figure 1-1a, b, and c, Project Location Maps, for location of Bear Creek and other streams). Ecology has established a total maximum daily load (TMDL) for fecal coliform in the Sammamish River. Development of a TMDL is one method Ecology uses to help clean up polluted waters. A TMDL is used to identify the maximum amount of a pollutant that can be released into a waterbody without impairing the designated uses of the water, and allocate that amount among various sources.

Table 1-1. Summary of Category 5 Polluted Waters within the Project Area

Water Body	Category 5: Polluted Waters/303(d) Parameters					
	Temperature	Fecal Coliform	Dissolved Oxygen	Total Phosphorus	Sediment Bioassay	Ammonia-N
North Fork Issaquah Creek		X				
Laughing Jacobs Creek		X				
Pine Lake Creek		X	X			
Ebright Creek		X				
George Davis Creek[1]		X				
Lake Sammamish						
South		X				X
Central East[2]		X	X	X	X	X
Central East[3]					X	X
Sammamish River	X		X			
Bear Creek	X	X				

1.`Listed as Eden Creek

2.`Near mouth of Pine Lake Creek

3.`Near mouth of George Davis Creek

1.4 SUMMARY OF DIFFERENCES BETWEEN ALTERNATIVES

Portions of the railroad right of way (referred to as the "corridor") have already been developed into the East Lake Sammamish Interim Use Trail, which has been evaluated in previous environmental documents. The Draft Environmental Impact Statement (EIS) evaluates the following alternatives for converting the existing Interim Use Trail into a permanent multi use, Master Plan Trail:

- No Action Alternative. King County would continue to operate the existing Interim Use Trail through the year 2015, at which time the permitted operation of the trail would expire without additional environmental review.
- No Trail Alternative. King County would immediately decommission the Interim Use Trail and close it to public use. No permanent Master Plan Trail would be built.
- Continuation of the Interim Use Trail Alternative. The existing Interim Use Trail would be continued beyond the currently approved 2015 sunset date; the gravel trail would be extended north beyond its current northern terminus, which is approximately 500 feet north of NE 70th Street; equestrian use would be allowed; and ancillary facilities would be added.

Figure

1-A East lake Sammamish Trail Alternatives – North Segment

Figure

1-B East lake Sammamish Trail Alternatives – Central Segment

Figure

1-C East lake Sammamish Trail Alternatives – South Segment

- Corridor Alternative. The multi-use trail proposed in this alternative would be located within the corridor. The trail would be wider than the Interim Use Trail and would be paved. The majority of the trail would encompass the Interim Use Trail, and the trail would leave the Interim Use Trail alignment only in those places where this would improve trail safety.
- East A Alternative. The multi-use trail proposed in this alternative would be located along the Interim Use Trail alignment in certain locations but would be paved and wider than the Interim Use Trail. In addition, the paved, multi-use portion of the trail would transition to the roadway shoulder at an Americans with Disabilities Act (ADA)-acceptable gradient at some driveway and public roadway intersections, along 1.7 miles of divided properties between SE 33rd Street and approximately the 1400 block of East Lake Sammamish Parkway SE, and to avoid sensitive areas (such as streams, wetlands, and vegetation). Where the alignment for the paved portion of the multipurpose trail moves to the roadway shoulder, pedestrian and equestrian use would continue on the existing gravel Interim Use Trail alignment.
- East B Alternative. The trail would be the same as planned in the East A Alternative except that, where the alignment for the paved portion of the multi-use trail moves to the roadway shoulder, pedestrians and equestrians would stay on the paved trail and the corridor would be closed to public use.

With reference to surface water and water quality, the main differences between the Master Plan Trail alternatives are the amount of new impervious surface that would be created by trail surfacing and the number of culverts that would be extended. Based on the assumptions and calculations presented in Section 4 Methodology, the Continuation of the Interim Use Trail Alternative would create new impervious surface only at new parking facilities and would not extend any culverts. The Corridor, East A, and East B Alternatives would create the same amount of new impervious surface at new parking facilities as the Continuation of the Interim Use Trail Alternative. In addition, the Corridor, East A, and East B Alternatives would create a ribbon of new impervious surfaces along the entire length of the trail and would extend the culverts on several streams. However, these three alternatives do not differ substantially in the amount of new impervious surface added in any one subbasin. In the following sections, the Continuation, Corridor, East A and East B Alternatives are occasionally considered together as the “Build Alternatives.”

1.5 SUMMARY OF IMPACTS

“Operational impacts” are impacts that would result from the long-term operation of the proposed project. The causes of operational impacts for this proposed project could be divided into four general categories: (1) new impervious surface area, (2) culvert extensions, (3) horse use, and (4) operational maintenance activities. The potential impacts associated with each category are described below. In general, none of the proposed alternatives are likely to have measurable adverse impacts to water resources in the project area.

“Construction impacts” are temporary impacts associated with construction activities. The proposed project could have temporary water-quality impacts associated with (1) stream diversions for culvert extensions on perennial streams and (2) dewatering, cast-in-place concrete, and stream diversions for retaining-wall construction.

1.6 COMPLIANCE WITH SURFACE WATER PLANS AND POLICIES

All of the proposed alternatives would comply with surface water plans and policies, including the following:

- Clean Water Act (CWA).
- Washington Administrative Code (WAC).
- City of Redmond Stormwater Technical Notebook (Redmond 1999).
- City of Sammamish Development Code (Sammamish 1999).
- City of Issaquah Development Code (Issaquah 1995).

Applicable local, state, and federal regulations and associated permits and approvals are discussed in Section 3 Permits and Approvals. Wellhead and Aquifer Protection Plans are discussed in the Geology Appendix (King County 2004a).

2. STUDIES AND COORDINATION

In the development of this discipline report, the following sources were used to gain pertinent existing and historical water-quality information in order to characterize the affected environment and potential impacts and develop mitigation measures:

- Literature found in library catalogs (University of Washington) and on the World Wide Web.
- *Stormwater Management Manual for Western Washington* (Ecology 2001); hereinafter referred to as the Ecology Manual[3].
- *King County Surface Water Design Manual* (King County 1998a); hereinafter referred to as the King County Manual[4].
- East Lake Sammamish Basin Plan (King County 1994a), Bear Creek Basin Plan (King County 1990a), and Issaquah Creek Basin Plan (King County 1994b).
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) (FEMA 1995, 1998).
- *East Lake Sammamish Trail Interim Use and Resource Protection Plan* (King County 1999a).
- Field reconnaissance.

In addition, the following agencies have been contacted either directly or via information on their website:

- Washington State Department of Ecology.
- Washington State Department of Fish and Wildlife.
- King County Water and Land Resources Division.
- City of Issaquah.
- City of Sammamish.
- City of Redmond.

Section 10 References provides literature references for other information used in developing this report.

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[3] The Washington State Department of Ecology Stormwater Management Manual for Western Washington is currently being updated. It is anticipated that a new manual will be published in December 2004.

[4] The King County Surface Water Design Manual is currently being updated. It is anticipated that a new manual will be adopted in late 2004 or early 2005. This section will be updated as needed when the new manual is adopted.

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3. PERMITS AND APPROVALS

This section summarizes the applicable regulations and the associated permits and approval processes for the development of the Master Plan Trail. Any activity that discharges stormwater into navigable waters must comply with the applicable provisions of Sections 301, 302, 306, and 307 of the CWA. Projects must also comply with all known, available, and reasonable methods of treatment (AKART) under state law, including effluent limitations under the CWA and any applicable, more stringent county or local limitations.

3.1 FEDERAL REGULATIONS

The CWA is the federal law regulating and issuing permits for the direct discharge of pollutants to water resources. Under the CWA, Section 402: National Pollutant Discharge Elimination System (NPDES) State Waste Discharge Individual Permit for Process Water and Storm Water, a NPDES permit is required for any discharge of pollutants into the waters of the United States. This project will require an NPDES Permit for construction activities, but not for its long-term operation. Permitted discharges must satisfy discharge permit requirements under Section 402 of the CWA and 90.48 Revised Code of Washington (RCW). In addition, FEMA has mapped 100-year floodplains within the project area's watersheds.

3.2 STATE REGULATIONS

Through the WAC, Ecology regulates discharges to surface waters within the state. Several chapters in the WAC address water quality. Chapter 173-201A WAC, Water Quality Standards for Surface Waters of the State of Washington, summarizes the state water-quality standards for ambient water quality. The Master Plan Trail project will design and implement BMPs in accordance with the applicable stormwater manuals and any permit conditions identified as part of the Section 401 Water Quality Certification, which certifies compliance with state water-quality standards. The certification process examines the effects of proposed projects related to the state water-quality standards and beneficial use.

Chapter 173-201A-070 WAC puts forth the antidegradation policy for water quality. The proposed Master Plan Trail would be a non-pollutant-generating, impervious surface; therefore, it would not affect the quality of stormwater runoff from the project area and would comply with WAC policy. The ancillary parking facilities proposed in the Build Alternatives would provide stormwater treatment to assure compliance with the applicable regulations and therefore would also comply with this WAC policy.

The Washington State Department of Fish and Wildlife (WDFW) issues hydraulic project approval (HPA) permits for any project that will work within the ordinary high water mark of streams. This permit will likely be required and would set guidelines for in-water work periods and BMPs.

3.3 KING COUNTY REGULATIONS

The King County Manual (King County 1998a) was developed to provide guidance for surface water management, both during the construction and operational phases of a project, including flow control and water-quality treatment. In addition to its general requirements, the County has incorporated the findings from the basin plans it developed for Lake Sammamish, Issaquah Creek, and Bear Creek into the King County Manual.

3.4 CITY OF REDMOND REGULATIONS

The city of Redmond has developed the Stormwater Technical Notebook – Issue No. 3 (Redmond 1999) to govern stormwater runoff management. This notebook is based on the requirements of the Ecology Manual (Ecology 1992). The city of Redmond also has a critical areas ordinance that would protect streams and wetlands in the project area.

3.5 CITY OF SAMMAMISH REGULATIONS

The city of Sammamish has developed the interim Sammamish Development Code (Sammamish 1999) and has adopted the King County Manual (King County 1998a). This manual provides guidance for stormwater management including detention and treatment as discussed in Section 3.3 King County Regulations. The city of Sammamish also has a critical areas ordinance that would protect streams and wetlands in the project area.

3.6 CITY OF ISSAQUAH REGULATIONS

The city of Issaquah has adopted the King County Manual (King County 1998a) for surface water management. This manual provides guidance for stormwater management including detention and treatment as discussed in Section 3.3 King County Regulations. The city of Issaquah also has a critical areas ordinance that would protect streams and wetlands in the project area (IMC 18.10.300).

4. METHODOLOGY

4.1 AFFECTED ENVIRONMENT – METHODOLOGY

The project corridor's western edge is defined by the western edge of the existing King County right of way. In locations where the proposed project would be located on the rail corridor, the eastern edge of the project corridor would be defined by the eastern edge of the existing King County right-of-way. In locations where the proposed project would be located east of the railroad corridor, either in transitional areas, adjacent to the East Lake Sammamish Parkway or East Lake Sammamish Place, the project's corridor would be defined by the eastern edge of the proposed trail.

The water resources that will be affected within the project corridor are characterized at the regional and site-specific levels. The regional-level characterization identifies and describes the watersheds within which the project corridor is located. This includes the Bear Creek, Sammamish River, East Lake Sammamish, and Issaquah Creek watersheds. However, the project corridor itself is located in only a small portion of each watershed; therefore, a more detailed site-specific characterization of streams and drainage systems were used to identify potential impacts on water resources.

4.2 IMPACT ANALYSIS – METHODLOGY

This section discusses the assumptions and methods used to evaluate potential impacts associated with the alternatives. In general, potential long-term impacts can be attributed to (1) new impervious surface, (2) culvert extensions and/or replacements, (3) horse use, and (4) operational maintenance activities. The methods and assumptions used to evaluate each impact are described in the following sections.

4.2.1 Impervious Surfaces Calculations

The following steps were used to evaluate potential impacts associated with an increase in the amount of impervious surface in each subbasin:

- Define impervious surface.
- Delineate subbasins.
- Calculate the effective impervious area.
- Determine the threshold of impacts.

The area of new effective impervious surface within each subbasin was estimated to evaluate potential impacts to streams and wetlands. The assumptions made and methods used at each step of the analysis are described in the following sections.

4.2.1.1 Definition of Impervious Surface

"Impervious surface" is defined as "any hard surface that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development" (King County 1998a). King County categorizes driveways, parking lots, and gravel roads as impervious surfaces. The following categories of impervious surfaces are used in this analysis: (1) existing impervious surface, (2) new impervious surface, (3) effective impervious surface (EIA), (4) replaced impervious surface, and (5) pollutant-generating impervious surface (PGIS). These are described below.

Existing Impervious Surface

For the purpose of the Master Plan Trail analysis, existing paved roads, driveways, and other impervious facilities, such as roofs, within the project corridor are considered existing impervious surfaces. The existing Interim-Use Trail consists of gravel located on railroad ballast and was not considered an existing impervious surface.

New Impervious Surface

New impervious surface is considered to be new, paved surfaces that would be located on (1) existing railroad ballast, (2) the interim trail gravel surface, or (3) native soil and new gravel surface that would replace native soil and vegetation. *The Interim Use Trail and Resource Protection Plan Final EIS* (King County 2000) and permitting agencies determined that the addition of gravel to the existing railroad ballast would not change the volume or rate of runoff. Therefore, gravel located on the existing railroad ballast was not considered new impervious surface. A cross section view illustrating the new impervious surface created under the Corridor, East A and East B Alternatives is shown on Figures 4-1 Corridor Alternative New Impervious Surface Typical Section and 4-2 East A and East B Alternatives New Impervious Surface Typical Section.

Effective Impervious Surface

Effective impervious surface is the actual portion of the new impervious surface that is connected to a drainage system (King County 1998a).

Replaced Impervious Surface

Replaced impervious surface is impervious surface created on top of existing impervious surface, such as existing driveways and parking areas that will be repaved. A cross section view illustrating the amount of replaced impervious surface created under the Corridor, East A and East B Alternatives is shown on Figure 4-3 Corridor, East A and East B Alternatives Replaced Impervious Surface Typical Section.

Pollutant-Generating Impervious Surface

PGIS is impervious surface that is a potentially significant source of pollutants in surface and stormwater runoff, such as a surface subject to vehicular use or used to store erodible or leachable materials, wastes, or chemicals (King County 1998a). Based on this definition, none of the new impervious surface created by the trail alignment would be a PGIS. The trail alignment will not be used by vehicles except for occasional maintenance and emergency vehicles. However, the proposed parking facilities would be a PGIS.

4.2.1.2 Subbasin Delineation

Subbasins were delineated using geographic information system (GIS) maps depicting topographic and drainage information, as well as through field investigations. A subbasin was defined as the area within the project corridor that drains to a cross culvert that in turn drains to Lake Sammamish, a stream, or a wetland. Subbasins were also defined using the King County (1998a) definition of a threshold discharge area. If flow conveyed under the trail at two different locations converges within a quarter mile of the edge of the project corridor, then the entire contributing area was considered a single subbasin. Within each subbasin, the receiving water was also identified. Streams were classified using WDFW stream classification system. Other identified drainage features include ditches and pipes that convey flow to Lake Sammamish.

Figure

4-1 Corridor Alternative New Impervious Surface Typical Section

Figure

4-2 East A and East B Alternatives New Impervious Surface Typical Section

Figure

4-3 Corridor, East A and East B Alternatives Replaced Impervious Surface Typical Section

4.2.1.3 Effective Impervious Surface

The areas of new impervious surface that would be created under each alternative (see Figures 4-1 Corridor Alternative New Impervious Surface Typical Section, 4-2 East A and East B Alternatives New Impervious Surface Typical Section, and 4-3 Corridor, East A and East B Alternatives Replaced Impervious Surface Typical Section) were calculated using GIS. The following assumptions were made when calculating these areas:

- Unpaved portions of the Corridor Alternative trail alignment proposed for paving and located either on the existing railroad ballast or on native soil are new impervious surface.
- Unpaved portions of the East A and East B Alternatives trail alignment proposed for paving and located on the either the existing gravel road shoulder or on native soil were considered for this analysis as new impervious surface. The 24.5-foot offset from the centerline of the road (23 feet to the edge of pavement and 1.5 feet for the curb and gutter), which was used for the trail design, was assumed to generally be greater than the existing edge of pavement line; therefore the trail was conservatively assumed to be constructed on the existing gravel road shoulder in these locations.
- Proposed gravel shoulders on both the East and Corridor Alternatives would replace existing native soil and are considered new impervious surface.
- The proposed separated soft-surface (i.e., gravel) trail would replace existing native soil and are considered new impervious surface.

To ensure that the greatest possible extent of potential impacts are evaluated, the assumptions used for this analysis are conservative. It is likely that in some locations along the Corridor Alternative alignment, the proposed gravel shoulders would be located on ballast, not native soil and therefore would not create new impervious surface. It is also likely that at some locations along the East Alternative alignment, the gravel shoulder would be located on a gravel road shoulder, not on native soil, and therefore would not create new impervious surface. These exceptions would reduce the potential impacts. More detailed analysis would be performed for the selected alternative during design and permitting.

Once the new impervious surface area for each alternative was calculated using GIS, subbasins where the new impervious surface area would be greater than 5,000 square feet were identified. From these, the subbasins that drain to a stream or wetland were selected. For these selected subbasins, the cross section and drainage system were evaluated. Areas of new impervious surface where runoff could be dispersed were subtracted from the total new impervious surface area to calculate the effective impervious surface area as shown in the following equation:

Total New Impervious Surface Area – Surface Area with Dispersed Flow =
Effective New Impervious Surface Area

In subbasins where all runoff would be collected and conveyed to a stream or wetland, all of the new impervious surface area was considered to be effective new impervious surface area. The amount of total and effective impervious surface is presented in Appendix C Total and Effective Impervious Surface Areas. It was assumed that only subbasins in which a stream or wetland was the receiving water could potentially be impacted. Lake Sammamish would not be affected by changes in the volume or rate of stormwater runoff. Because none of the alternatives would clear forested areas, it was assumed the volume of runoff would be the same for each alternative and that the main difference among them would be potential changes in the rate of stormwater runoff.

4.2.1.4 *Threshold for Impacts*

The King County Manual was used to determine the stormwater management requirements for the project area (King County 1998a). Because this manual exempts projects that create less than 5,000 square feet of impervious surface area from flow control, it was assumed that wetlands and streams located in subbasins in which the project would create less than 5,000 square feet of new effective impervious surface would not be impacted by an increase in flow rates or flow volume. The Ecology Manual states, "When the standards and recommendations of this manual [or an equivalent] are properly applied, stormwater runoff should generally comply with water quality standards and protect beneficial uses of the receiving waters" (Ecology 2001).

4.2.2 Culvert Extensions

A review of literature was used to identify potential impacts related to culvert extensions. The locations in the project area where culverts potentially would be extended were identified (Appendix D Extended Culvert Table). From among these locations, culverts that convey a stream and locations of known flooding and local drainage problems were assumed to be potential areas of impact.

4.2.3 Horse Use

Potential impacts to water quality as a result of equestrian use were qualitatively evaluated using the following methods:

- A review of literature on the composition of horse manure and its potential pollutants and nutrients.
- Research regarding projected horse use.
- A review of literature on the potential for pollutants and nutrients to enter surface water.

4.2.4 Long-Term Maintenance Impacts

For all the alternatives, maintenance activities that could temporarily increase turbidity were qualitatively evaluated. It was assumed that maintenance activities along the project corridor would be the same for all alternatives.

5. AFFECTED ENVIRONMENT

The project corridor lies adjacent to the eastern shoreline of Lake Sammamish in WRIA 8: Cedar-Sammamish Watershed and is located within four major watersheds: Issaquah Creek, East Lake Sammamish, Sammamish River, and Bear Creek (Figure 5-1 Project Area). Most of the project corridor lies within the East Lake Sammamish Watershed, which includes several smaller basins and subbasins (Figure 5-2 East Lake Sammamish Watershed). Numerous perennial and intermittent streams, seeps, and wetlands lie within the project corridor. The hydrology, water quality, and floodplains associated with the major surface water features within the project corridor are discussed below. In general, development has occurred in these watersheds and the natural hydrologic regime and water quality have been altered. Additional information about wetlands can be found in the Wetland Biology Discipline Report (King County 2005). Additional information about fisheries, groundwater, geology, and soils is provided in the East Lake Sammamish Master Plan Trail Draft Environmental Impact Statement.

5.1 CLIMATE

The climate of the project corridor is influenced by the low rolling hills and sheltered inland salt water that make up the Puget Sound Basin. This geography produces a mild, marine climate characterized by wintertime clouds, rain, and light snow and summertime sunshine.

Winter temperatures range from approximately 50 degrees Fahrenheit (°F) to approximately 30°F. Summers are warm, ranging from approximately 75°F to 50°F. The Seattle area has an average annual precipitation of 38.3 inches per year (NOAA 2003).

5.2 GEOLOGY, TOPOGRAPHY, AND SOILS

The proposed project corridor is located in the central portion of the Puget Sound Basin, an elongated, north-south trending depression situated between the Olympic Mountains and the Cascade Range in Western Washington. The existing topography in the project area is heavily influenced by past glacial activity. The topography is dominated by a series of north-south trending ridges and large troughs formed by glacial activity. The major troughs are now occupied by Puget Sound, Lake Washington, Lake Sammamish, and other large water bodies.

The project corridor traverses variable geologic conditions along the eastern slope of the Lake Sammamish trough. This slope has a topographic relief of approximately 400 feet from the Sammamish Plateau on the east side to Lake Sammamish on the west. The northern and southern ends of the corridor traverse unconsolidated alluvium along flat-lying plains. The elevation of the corridor lies between approximately 10 to 110 feet above Lake Sammamish.

Surface and subsurface soils in the plains at the north and south ends of Lake Sammamish consist of alluvium and lake deposits. Soils along hillsides typically consist of overconsolidated glacial deposits, overlain by variable thicknesses of colluvium (slope deposits) and locally by alluvium. The native soils were modified by cut and fill earthwork for construction of the railbed, parkway, streets, and homes.

Additional information related to the geology, topography and soils in the project area is provided in the Geology Appendix (King County 2004a).

5.3 LAND USE

The project corridor crosses a number of watersheds in areas that have experienced rapid urban and suburban growth in recent years. The entire project corridor is located either within the King County urban growth boundary (UGB) or within incorporated portions of King County, including the cities of Issaquah, Sammamish, and Redmond.

The southern end of the project corridor is adjacent to Lake Sammamish State Park, which covers approximately 512 acres. The southernmost portion of the project is located in the city of Issaquah. Land use in areas adjacent to the project corridor in Issaquah is primarily retail and commercial development, with smaller areas of low-density residential, office, and community facilities. The city of Issaquah Comprehensive Plan estimates that the number of households within the current city limits and the potential annexation areas (PAAs) will increase by 40 percent by the year 2022 (Issaquah 2002).

The middle portion of the project corridor lies within the city of Sammamish, including the East Lake Sammamish Watershed. Although no estimate was made of the percentage of land use in the “built out” condition of the city of Sammamish, it is estimated that there will be a 30 percent increase in the number of single-family homes. However, the city of Sammamish declared a moratorium on building permits in August of 2000 (Sammamish 2004). The moratorium has been extended a number of times since inception, most recently through August 14, 2004 (Sammamish 2004).

The northern segment of the project, including the Sammamish River and Bear Creek watersheds, is within the city of Redmond. Land use in this segment currently ranges from low and low-moderate density residential in the south end to manufacturing park, general commercial, and city center in the north end. The zoning creates a reasonable expectation of future expansion and population growth.

5.4 NORTH FORK ISSAQUAH CREEK WATERSHED

The North Fork Issaquah Creek, which is a tributary to Issaquah Creek, has a drainage area of approximately 2,855 acres in the southern portion of the Lake Sammamish Watershed and contains a portion of the project corridor. Issaquah Creek, including the North Fork, is to be protected for the following uses: non-core salmon and trout rearing and migration; primary contact recreation; domestic, industrial, and agricultural water supply; livestock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (Ecology 2004). For purposes of this analysis, the North Fork Watershed was further divided into smaller subbasins (Appendix A Project Corridor Subbasin Maps). Flow in this watershed originates from the Sammamish Plateau at Yellow Lake and enters the main fork of Issaquah Creek just upstream of Lake Sammamish. The North Fork of Issaquah Creek is low gradient in the upper and lower reaches but flows through a steep ravine near the middle of the watershed. Water quality in the North Fork has been impacted by runoff from impervious surfaces located in the city of Issaquah and from discharges from a storm sewer outfall at River Mile (RM) 0.2, which is upstream of the project site (King County 1994b). Ecology has listed the North Fork of Issaquah Creek in Category 5 for fecal coliform and Category 4c, Waterbodies Impaired by a nonpollutant for fish habitat (Ecology 2004).

Flooding is concentrated in the lower reaches of the watershed where FEMA has mapped a 100-year floodplain (FEMA 1995) (see Figure 5-1 Project Area). However, fill elevates the Interim Use Trail (i.e., former railbed) above the 100-year flood elevation.

Figure

5-1 Project Area

Figure

5-2 East Lake Sammamish Watershed

5.5 EAST LAKE SAMMAMISH WATERSHED

The 16-square-mile East Lake Sammamish Watershed is composed of six major basins (from south to north): Laughing Jacobs, Pine Lake, Thompson, Monohon, Inglewood, and Panhandle, as well as numerous smaller subbasins (Appendix B Project Corridor Stream and Culvert Table) (see Figure 5-2 East Lake Sammamish Watershed).

These basins are drained by 17 perennial streams and numerous additional intermittent streams and drainage routes (King County 1999b). These streams are to be protected for the following beneficial uses: salmon and trout spawning; non-core salmon and trout rearing and migration; primary contact recreation; domestic, industrial, and agricultural water supply; livestock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (Ecology 2004).

Generally, these streams originate in wetlands located on the Sammamish Plateau and drain west through steep ravines to Lake Sammamish. Numerous seeps also emerge along the base of the plateau and supply additional surface water to streams and wetlands. Rapid and intense development has degraded the hydrology and water quality in Lake Sammamish and the numerous streams that drain into the lake (King County 1990b).

The project corridor is located along the base of the Sammamish Plateau and generally runs perpendicular to natural drainage routes. Local flooding and drainage problems, common within the project corridor, have been attributed to (1) alteration of natural drainage patterns related to the construction and operation of both the railroad and the East Lake Sammamish Parkway, (2) residential development, (3) natural seeps and springs, and (4) poorly maintained local drainage systems. The main basins and surface water features of the East Lake Sammamish Watershed are discussed in detail in the following sections.

5.5.1 Lake Sammamish

Lake Sammamish, with a surface area of approximately 4,900 acres, is one of the largest lakes in the Puget Sound Basin (King County 1999c). The lake receives flow primarily from Issaquah Creek and discharges north through the Sammamish River to Lake Washington, Lake Union, and Puget Sound.

Lake Sammamish is listed by King County as sensitive because water quality studies conducted over the last 30 years have demonstrated that the lake is sensitive to phosphorus loading (King County 1990b; 1995). In 1968, Municipality of Metropolitan Seattle (Metro) completed a water-quality improvement project that ended direct discharges of sewer effluent to Lake Sammamish (King County 1999b). Along the eastern portion of Lake Sammamish, adjacent to the project area, Ecology has listed Lake Sammamish in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for total phosphorus, sediment bioassay, ammonia-N, fecal coliform, and dissolved oxygen (Ecology 2004). Lake Sammamish is to be protected for the following beneficial uses: Salmon and trout spawning; non-core salmon and trout rearing and migration; extraordinary primary contact recreation; domestic, industrial, and agricultural water supply; livestock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (Ecology 2004).

FEMA has mapped a 100-year floodplain, designated Zone X; which are areas in the 100-year floodplain with less than 1-foot average depth or less than one square mile drainage area; or areas protected by a levee, along the eastern edge of the lake. Portions of the project corridor are located within the floodplain (FEMA 1995) (see Figure 5-1 Project Area).

5.5.2 Laughing Jacobs Basin

The Laughing Jacobs Basin includes approximately 3,600 acres of the southern portion of the East Lake Sammamish Watershed. This basin is drained by Laughing Jacobs Creek, which begins in Wetland 26 (also known as Laughing Jacobs Lake), flows through a steep ravine, and discharges to Lake Sammamish near the state park. Ecology has listed Laughing Jacobs Creek in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for fecal coliform and in the Category 4c, Waterbodies Impaired by a nonpollutant for instream flow and fish habitat (Ecology 2004). The stream also has high phosphorus content from agricultural land uses and high sediment loads due to active landslides in the lower reaches of the stream (the upper portions are underlain by bedrock) (King County 1990b).

FEMA has not designated a 100-year floodplain for Laughing Jacobs Creek (see Figure 5-1 Project Area). The FEMA FIRM for King County (FEMA 1995) shows that the Interim Use Trail is located in a Zone X flood area. These are defined as areas in a 500-year floodplain; areas in the 100-year floodplain with less than 1 foot average depth or less than 1 square mile drainage area; or areas protected by a levee. However, hydraulic modeling of the stream has been used to map a local floodplain within the project corridor (King County 1999b) and results from this hydraulic modeling indicate that the Interim Use Trail is located above the flood stages predicted for a 100-year storm event. The Interim Use Trail crosses the stream on a bridge, which has the capacity to accommodate water volumes associated with a 100-year flood event.

5.5.3 Pine Lake Basin

The Pine Lake Basin covers approximately 773 acres in the middle of the East Lake Sammamish Watershed. Pine Lake Creek originates on the Sammamish Plateau in Pine Lake and Wetland 24 (see Figure 5-2 East Lake Sammamish Watershed). The stream then drains west to Lake Sammamish through a steep ravine composed of glacial till soils underlain with highly erodible, sandy outwash soils. The main tributary, Kanim Creek, joins Pine Lake Creek upstream of the project corridor. Downstream of the Interim Use Trail (i.e., the former railbed), boulders and large woody debris have been added to the stream to enhance habitat. Ecology has listed Pine Lake Creek in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for dissolved oxygen and fecal coliform (Ecology 2004). Although FEMA has not mapped a 100-year floodplain, hydraulic studies indicate that the Interim Use Trail alignment is outside the local floodplain (King County 1999a). Two 36-inch-diameter concrete pipes convey Pine Lake Creek under the Interim Use Trail. Although these pipes can accommodate 100-year storm event flows, a King County capital improvement project (CIP) recommends that they be replaced with a bridge (King County 1994a). This CIP has not yet been completed.

5.5.4 Thompson Basin

The Thompson Basin covers approximately 1,176 acres in the middle of the East Lake Sammamish Watershed. Ebright Creek is the most notable drainage feature in this basin. It is fed by two tributaries that originate on the Sammamish Plateau in Wetlands 14, 17, 61, and 62 (King County 1994a). In the project corridor, large woody debris and boulders have been placed in the channel to reduce erosion and enhance instream habitat. King County (1994a) has documented erosion problems in the upper watershed and sedimentation problems in the lower watershed. Ecology has listed Ebright Creek in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for fecal coliform and in the Category 4c, Waterbodies Impaired by a nonpollutant for instream flow and fish habitat (Ecology 2004).

FEMA has not mapped a floodplain in the project corridor. However, a hydraulic study indicates that the Interim Use Trail alignment lies outside the 100-year flood event flood elevation (King County 1999a). A 36-inch-diameter concrete pipe and a 36-inch-diameter corrugated metal pipe (CMP) convey the stream under the Interim Use Trail.

5.5.5 Monohon Basin

The Monohon Basin is divided into the north, middle, and south stream drainages along the eastern edge of Lake Sammamish. The main features of each stream in this basin are summarized in Table 5-1 Streams in the Monohon Basin, East Lake Sammamish Watershed. Much of this basin drains directly to Lake Sammamish without forming a distinct channel.

Table 5-1. Streams in the Monohon Basin, East Lake Sammamish Watershed

Stream ID	Corridor Alternative Station	East A Alternative Station	Drainage	Classification[1]	WDWF Stream Type
Many Springs Creek	211+90	212+20	South Monohon	Perennial	Type 3
0163	239+00	239+10	South Monohon	Perennial	Type 3
Zaccuse Creek	421+10	420+90	North Monohon	Perennial	Type 3

1 Classification based on King County investigations (1994a)

The southern drainage area contains three notable streams: Many Springs Creek, Stream No. 0163, and Stream No. 0162A (an intermittent stream). Many Springs Creek has been subject to both channel incision and downstream sedimentation. Although Ecology has not included this stream in the 303(d) List, its water quality has been impaired by fine sediment deposition. Many Springs Creek is channeled under the Interim Use Trail through a 24-inch-diameter CMP. Modeled flow data predict flooding under existing development conditions during a storm event with a 25-year or greater return-frequency discharge rate (King County 1994a). Stream Nos. 0163 and 0162A have no reported water-quality problems (King County 1994a). Stream No. 0163 is conveyed under the Interim Use Trail by a 24-inch-diameter clay pipe; no evidence of flooding or capacity problems was observed during field investigation. Stream No. 0162A is conveyed by a 24-inch-diameter concrete pipe, which was reported to be undersized (King County 1999a).

The middle drainage area, located between the Pine Lake and Thompson Basins, is drained by Stream No. 0155 (see Figure 5-1 East Lake Sammamish Watershed). The stream is conveyed under the Interim Use Trail in a 12-inch-diameter CMP. No evidence of flooding problems was observed during a winter 1999 field investigation.

The northern drainage area in the Monohon Basin is located between the Inglewood and Thompson Basins. Zaccuse Creek is the primary drainage feature in this drainage area. Zaccuse Creek originates in a series of wetlands and flows northwest to Lake Sammamish. Channel incision has been reported in the middle reaches of Zaccuse Creek and sedimentation has occurred in the downstream reaches, resulting in degraded water quality. No other water-quality problems have been reported in the area (King County 1994d). FEMA has not mapped a floodplain along this stream. Zaccuse Creek is conveyed under the Interim Use Trail by a 36-inch-diameter, concrete pipe; no flooding problems have been reported, although flooding is expected under existing land-use conditions assuming a storm event with a 25-year or greater return-frequency discharge rate (King County 1994d).

5.5.6 Inglewood Basin

The Inglewood Basin covers approximately 1,559 acres and drains through George Davis Creek (known locally as Inglewood or Eden Creek). George Davis Creek originates on the Sammamish Plateau in a network of wetlands and springs.

Water-quality monitoring in this stream indicates problems with *Enterococcus* bacteria and nitrogen, possibly due to septic tanks (in a neighborhood serviced by septic systems west of 228th Street that is frequently flooded) and sewer system leaks. Sediment deposition, common within the project corridor, may also degrade water quality and habitat (King County 1994a). Ecology has listed George Davis Creek in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for fecal coliform, in the Category 4c, Waterbodies Impaired by a nonpollutant for instream flow and fish habitat, and in the Category 2: Waters of Concern for copper and pH (Ecology 2004).

FEMA has not mapped a floodplain associated with this stream. A large, arched culvert conveys George Davis Creek under East Lake Sammamish Parkway. Two concrete pipes (36 inches and 24 inches in diameter) currently convey the stream under the Interim Use Trail. Although these pipes have the capacity to convey existing flows, King County has recommended a CIP that would replace them with a single 72-inch-diameter pipe (King County 1994a). The stream enters another pipe downstream of the Interim Use Trail and flows under a house before reaching the lake. George Davis Creek was reported to have flooded adjacent properties during storm events in 1991, 1994, and 1996 (King County 1999c). Local flooding along the former railbed is also common (King County 1994a).

5.5.7 Panhandle Basin

The Panhandle Basin, located in the northern portion of the East Lake Sammamish Watershed, is approximately 3 miles long and relatively narrow. The basin is drained by eight perennial streams (Table 5-2 Streams in the Panhandle Basin, East Lake Sammamish Watershed) and numerous intermittent streams and seeps, which feed characteristically short, high-gradient channels (Appendix B Project Corridor Stream and Culvert Table) (King County 1994c). Residential development is concentrated along the shores of Lake Sammamish and in portions of the upper watershed (King County 1994c).

Table 5-2. Streams in the Panhandle Basin, East Lake Sammamish Watershed

Stream ID	Corridor Alternative Station[1]	East A Alternative Station	Classification[2]	WDFW Stream Type
0143L	460+95 and 456+90	457+40	Perennial	Type 3
0143K	470+50	n.a.	Perennial	Type 3
0143J	484+10	483+10	Perennial	Type 3
0143H	500+35 and 499+50	499+50 and 498+70	Perennial	Type 3
0143M	507+55	506+65	Perennial	Type 3
0143G	522+60	521+75	Perennial	Type 3
0143F	525+10	524+25	Perennial	Type 3
0143A	596+20	595+40	Perennial	Type 4/5

1 Project stationing is described by the two major Build Alternatives: the Corridor Alternative and the East A Alternative. (See Section 6 Operational Impacts.)

2 Channel descriptions based on Parametrix field investigations.

Note: n/a = not applicable

King County field surveys noted no significant water-quality problems other than total suspended sediment in any of the Panhandle Basin drainages. However, all of these drainages have problems with incision in steep stream reaches and with sedimentation in the lower reaches (King County 1994a).

Floodplains are not mapped by FEMA for any of the streams in this basin. However, numerous drainage and local flooding problems within the project corridor due to seeps and poor conveyance systems have been reported. Local drainage and flooding problems are primarily due to sediment deposition blocking pipes and ditches and altered flow regimes (King County 1994a).

5.6 SAMMAMISH RIVER WATERSHED

The Sammamish River Watershed drains a total of 150 square miles. However, all but 26 square miles of this corridor drains through Lake Sammamish and Bear Creek (King County 1993). The Sammamish River flows north, connecting Lake Sammamish with Lake Washington. The Sammamish River is approximately 13 miles long and relatively linear, with a uniform channel configuration along much of its length. The Sammamish River is to be protected for the following beneficial uses: salmon and trout spawning; non-core salmon and trout rearing and migration; primary contact recreation; domestic, industrial, and agricultural water supply; livestock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (Ecology 2004). Land use adjacent to the river is a combination of urban, residential, and agricultural uses. The proposed alignment of the Master Plan Trail is the same for all alternatives in the Sammamish River Watershed. A portion of the Master Plan Trail would be located within three basins draining to the Sammamish River (Appendix A Project Corridor Subbasin Maps). However, this portion of the trail is located approximately one mile from the river, near its source (Lake Sammamish), and no concentrated surface runoff from the project corridor would reach the river.

North (downstream) of the project corridor, Ecology has listed the Sammamish River in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for temperature and dissolved oxygen, listed in Category 4A: Polluted Waters that have a TMDL for fecal coliform, and in the Category 2: Waters of Concern for dissolved oxygen, temperature and pH (Ecology 2004). North of the project corridor, FEMA has designated an extensive 100-year floodplain for the Sammamish River (see Figure 5-1 Project Area).

5.7 BEAR CREEK WATERSHED

Bear Creek Watershed, located north of Lake Sammamish, covers approximately 51 square miles and drains into the Sammamish River in Redmond. The proposed project corridor crosses the lower reach of the main stem of Bear Creek on an existing bridge. Only one project basin is located in the Bear Creek Watershed, and only approximately 828 linear feet of the proposed trail would be located in this basin. Bear Creek is to be protected for the following designated uses: salmon and trout spawning; non-core salmon and trout rearing and migration; primary contact recreation; domestic, industrial, and agricultural water supply; livestock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values (Ecology 2004).

King County has designated the lower reaches of Bear Creek as a “regionally significant resource area” because of its excellent habitat and water quality. It is one of the most productive salmon spawning streams in the Puget Sound Basin (King County 1990a). Although Bear Creek has excellent water quality, within the project corridor, Ecology has listed it in the Category 5: Polluted Waters/303(d) List of Threatened and Impaired Water Bodies for temperature and fecal coliform, and listed in the Category 2: Waters of Concern for dissolved oxygen and pH (Ecology 2004). The proposed alignment of the Master Plan Trail is the same for all alternatives in the Bear Creek Watershed (Appendix A Project Corridor Subbasin Maps). The trail would cross the stream and FEMA floodplain on the existing railroad bridge (see Figure 5-1 Project Area) (FEMA 1998). No local drainage or flooding problems have been reported in this corridor.

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6. CONSTRUCTION IMPACTS

The construction-related impacts of the project would be temporary and could be minimized or prevented through the proper implementation of BMPs. The causes of construction impacts are grouped into five general types: (1) erosion and sedimentation; (2) staging; (3) culvert extensions or replacements in perennial streams; (4) dewatering, cast-in-place concrete work, and stream diversions associated with retaining wall construction, and (5) work in and adjacent to wetlands. Construction-related impacts to receiving waters associated with each alternative are discussed in the following sections.

6.1 NO ACTION

Under the No Action Alternative, no construction activities would occur, therefore, no construction-related impacts would occur.

6.2 NO TRAIL ALTERNATIVE

Under the No Trail Alternative, construction activities would be limited to the removal of existing signage and fencing (posts will be cut at ground level) and installation of trail closure signage and barriers. No construction activities that could potentially cause environmental impacts (e.g., clearing and grading, removal of existing gravel or fence footings) would occur.

6.3 CONSTRUCTION IMPACTS COMMON TO ALL BUILD ALTERNATIVES

Clearing and grading, particularly in locations adjacent to wetlands could temporarily increase turbidity in site runoff. The location of work in and adjacent to wetlands is discussed in the Wetland Discipline Report (King County 2004b). These impacts would likely be caused by the erosion of disturbed soil areas or soil stockpiles and stormwater runoff transporting silt and sediment to receiving water. Stormwater runoff may also carry other contaminants, such as fuel and oil from construction operations, particularly at staging areas. Sediment and other contaminants can increase turbidity and affect other water-quality parameters, such as the amount of oxygen available in the water. Impacts associated with spills are most likely to occur at staging areas. Potential impacts to groundwater quality are not likely and are addressed in the Geology Appendix of the EIS (King County 2004a).

6.4 CONTINUATION OF THE INTERIM USE TRAIL ALTERNATIVE

The Continuation of the Interim Use Trail Alternative would not require the extension or replacement of culverts during construction. Therefore, construction impacts would be less than those of the Corridor or East A and East B Alternatives. Impacts due to clearing or grading would be the same as those of the Corridor, East A, and East B Alternatives at the ancillary facility locations. During construction of the interim use trail north of NE 70th Street BMPs and proper construction techniques would prevent any gravel from falling into the stream.

6.5 CORRIDOR ALTERNATIVE

The Corridor Alternative would extend or replace nine culverts on eight perennial streams (Table 6-1 Perennial Streams Temporarily Impacted by the Corridor and East A Alternatives). Construction impacts are only likely to occur on perennial streams because these culvert extensions or replacements would likely require a stream diversion during construction, increasing turbidity and temporarily impacting water quality. In addition, construction of retaining walls would likely require temporary dewatering. The water resulting from the dewatering process would be treated, as needed, prior to discharge to minimize or prevent impacts to the receiving water.

Table 6-1. Perennial Streams Temporarily Impacted by the Corridor and East A Alternatives

Subbasin	Corridor Station	East A Station	Associated Stream	Culvert Extended	
				Corridor Alternative	East A Alternative
172A	145+00	145+00	Unnamed Stream	YES	YES
167A	N.A.	211+15	Many Springs Creek	NO	YES
	211+90	212+20	Many Springs Creek	NO	YES
163A	n.a.	136+50	Stream 0163 Trib.	n.a.	YES
	237+45	237+45	Stream 0163	NO	YES
	239+00	239+10	Stream 0163	NO	YES
144A	n.a.	375+50	Pine Lake Creek	n.a.	YES
	376+10	n.a.	Pine Lake Creek	NO	n.a.
	376+15	n.a.	Pine Lake Creek	NO	n.a.
139A	421+10	420+90	Zaccuse Creek	YES	YES
136A	n.a.	433+40	George Davis Creek	n.a.	YES
	n.a.	435+50	George Davis Creek	n.a.	YES
	n.a.	437+90	George Davis Creek	n.a.	YES
	437+90	n.a.	George Davis Creek	YES	n.a.
	437+94	n.a.	George Davis Creek	YES	n.a.
129A	470+50	469+00	Stream 0143K	YES	YES
127A	484+10	483+10	Stream 0143J	YES	YES
123A	499+85	499+00	Stream 0143H	YES	YES
122A	507+55	506+55	Stream 0143M	YES	YES
119A	525+10	524+25	Stream 0143F	YES	YES
Total				**9**	**17**

Note: n.a. = not applicable

6.6 EAST A ALTERNATIVE

The East A Alternative would extend or replace 17 culverts on 12 perennial streams (see Table 6-1 Perennial Streams Temporarily Impacted by the Corridor and East A Alternatives) and could have temporary impacts on Many Springs Creek, Stream 0163, Pine Lake Creek, and Stream 0143G that the Corridor Alternative would not. Construction of retaining walls would likely require temporary dewatering. The water resulting from the dewatering process would be treated, as needed, prior to discharge to minimize or prevent impacts to the receiving water.

6.7 EAST B ALTERNATIVE

The East B Alternative would have the same construction impacts as the East A Alternative because it would extend or replace the same culverts and require construction of the same retaining walls.

7. OPERATIONAL IMPACTS

As stated above in Section 1.4 Summary of Impacts, the causes of operational impacts for this proposed project can be divided into four general categories: (1) new impervious surface, (2) culvert extensions, (3) horse use, and (4) maintenance. The potential impacts associated with each category are described below.

New impervious surface has been linked to increases in the frequency of peak flow rates and the volume of stormwater runoff. Both of these could result in increases in bed incision and bank erosion, particularly in steep stream reaches, and altered hydroperiod in wetlands. Eroded sediment is deposited as the stream slope decreases, which could lead to drainage problems and local flooding. In addition, large areas of new impervious surface could reduce groundwater recharge and summer low flow, increase summer temperatures. However, the project corridor makes up a very small part of the overall watershed, rendering the impacts of increased erosion and reduced groundwater recharge and temperature increases minimal.

Culvert extensions may decrease the efficiency of the drainage system to convey sediment and could also cause an increase in local scour and erosion at the downstream end of the culvert (Whipple et al. 1981).

Precipitation contacting horse manure could contaminate runoff and have detrimental impacts on water quality and fish habitat, particularly if it is unmanaged. It may also be a non-point source of nutrients, such as nitrogen and phosphorus, bacteria, and excess minerals (King County 2003a, b; Swinkler and Davies 2003). However, horse manure is not anticipated to result in a measurable increase in nutrients, bacteria, and minerals in the watershed because (1) some of the horses using the trail will be from other locations within the East Lake Sammamish, Issaquah, or Bear Creek watersheds and would not be a new source of pollutants in the watershed, (2) fences will protect wetlands and streams from direct horse impacts, (3) vegetation located between the trail and streams, wetlands, and Lake Sammamish will filter nutrients in many locations along the project corridor and thereby protect water quality, and (4) BMPs such as a manure management plan. Vegetated buffers have been shown to remove sediment and nutrients from nonpoint source runoff; therefore, it is likely that any pollutants associated with manure would be removed by buffers prior to reaching the receiving water (Lowrance et al. 1984; Lowrance et al. 1985; Johnson and Ryba 1992; Osborne and Kovacic 1993; Daniels and Gilliam 1996; Castelle et al. 1994).

Maintenance includes the removal of sediment and vegetation from ditches and streams, the annual repair and replacement of one to three culverts, as needed, the repair of gravel and pavement, and mowing. Although maintenance work is scheduled to occur during the summer dry months, emergency maintenance is likely during or following large storms if ditches or culverts fail or are blocked with debris. Ongoing, temporary impacts to water quality due to increased turbidity during maintenance activities are likely, but should lessen as culverts and drainage systems are repaired and/or replaced.

Potential impacts to fish are documented in the Fisheries Appendix of the EIS (King County 2004a). Potential impacts to wetlands are documented in the Wetlands Biology Discipline Report (King County 2004b). Potential impacts to groundwater quality are documented in the Geology Appendix of the EIS (King County 2004a).

7.1 NO ACTION ALTERNATIVE

Under the No Action Alternative, King County would continue to maintain the drainage system that currently serves the railroad alignment as described and evaluated in the State Environmental Policy Act (SEPA) and the National Environmental Policy Act (NEPA) documents for the Interim Use Trail.

7.2 NO TRAIL ALTERNATIVE

Under the No Trail Alternative, King County would continue to maintain the drainage system that currently serves the railroad alignment as described and evaluated in the SEPA EIS (King County 2000) and NEPA documents (FHWA and WSDOT 2002) for the Interim Use Trail for as long as King County owns the corridor. It is likely that this maintenance would be required to maintain the function of the drainage system regardless of ownership.

7.3 IMPACTS COMMON TO ALL BUILD ALTERNATIVES

All of the Build Alternatives would open the trail corridor to horse use. All the Build Alternatives would include the same associated ancillary facilities: crosswalks, sidewalks, curbs and gutters, and three parking and restroom facilities. Only the parking facilities would create new PGISs and could have potential water-quality impacts. It is well documented that runoff from PGISs, particularly in urban environments, contains pollutants that can impact the water quality of the receiving water. Pollutant loads in stormwater runoff vary depending on the amount and type of PGIS, traffic volume, duration and intensity of a storm event, time of year, antecedent weather condition, and several other factors, making it difficult to estimate potential pollutant loads (Driscoll et al. 1990). However, pollutant load is correlated to the area of PGIS and, therefore, can be estimated; these estimates are summarized in Table 7-1 Summary of PGIS Associated with Ancillary Parking Facilities.

Table 7-1. Summary of PGIS Associated with Ancillary Parking Facilities

Ancillary Parking Facilities	Receiving Water	Area (ft^2)
Bark Property	Stream 0143K	28,300
SE 33rd Street	Stream 0162A	26,140

The proposed project would provide water detention and water-quality treatment meeting all applicable standards. Non-traditional stormwater techniques such as the use of permeable pavers, and bioretention swales will be considered for stormwater management at these sites. It was assumed that no additional property would be acquired for construction of detention facilities (Appendix E Ancillary Facility Stormwater Management Feasibility).

7.4 CONTINUATION OF THE INTERIM USE TRAIL ALTERNATIVE

Potential impacts to water resources under the Continuation of the Interim Use Trail Alternative are discussed in Section 6.3 Impacts Common to All Build Alternatives. This alternative would not extend any culverts or create new impervious surface outside the ancillary facilities. Therefore, this alternative would not have any unique impacts.

7.5 CORRIDOR ALTERNATIVE

By widening the Interim Use Trail (i.e., former railbed) prism, paving the existing gravel surface, and creating new gravel shoulders, the Corridor Alternative would create a linear ribbon of new impervious surface along the length of the project corridor. The Corridor Alternative would create approximately 23.9 acres of new impervious surface along the trail corridor, 15.3 acres of which would likely be effective impervious surface. Under this alternative, more than 5,000 square feet of new impervious surface would be created in each of 38 subbasins that drain to streams and wetlands (Table 7-2 Subbasins with More than 5,000 ft^2 of New Effective Impervious Areas Draining to Streams or Wetlands; Appendix C Total and Effective Impervious Surface Areas). Appendix C Total and Effective Impervious Surface Areas shows the distribution and total amount of new impervious surface area created by the Corridor Alternative.

The Corridor Alternative would provide stormwater management for the subbasins in accordance with the applicable surface water standards, which would minimize the potential impacts to the environment due to increases in impervious surface area.

Table 7-2. Subbasins with More than 5,000 ft^2 of New Effective Impervious Areas Draining to Streams or Wetlands

Subbasin Name	Receiving Water	Corridor Alternative New EIA (ft^2)	East Alternative New EIA (ft^2)
175	Wetland 10C	20,631	20,631
174	North Fork Issaquah Creek	22,536	22,536
173	Unnamed Stream	20,376	20,376
172	Unnamed Stream	57,574	57,574
170	Wetland 4D/4E	31,398	31,398
168	Laughing Jacobs	9,298	9,203
167	Many Springs	12,798	12,312
166	Unnamed Stream	10,036	10,036
165	Wetland 13A	12,283	13,328
163	Stream 0163	3,613	5,208
161	Unnamed Stream	17,343	18,716
159	Stream 0162A	10,992	8,503
155	Unnamed Stream	11,131	8,880
153	Wetland 18C	7,100	10,153
151	Wetland 19B	16,239	14,207
148	Unnamed Stream	8,317	12,694
146	Unnamed Stream	9,487	8,053
143	Stream 0155	9,656	9,490
141	Stream 0150A	16,760	17,324
140	Ebright Creek	9,350	9,242
139	Zaccuse Creek	17,621	18,215
136	George Davis Creek	8,460	6,017

Table 7-2. Subbasins with More than 5,000 ft^2 of New Effective Impervious Areas Draining to Streams or Wetlands (continued)

Subbasin Name	Receiving Water	Corridor Alternative New EIA (ft^2)	East Alternative New EIA (ft^2)
135	Unnamed Stream	10,910	12,605
134	Unnamed Stream	5,958	5,425
130	Stream 0143L	11,574	13,505
129	Stream 0143K	14,822	10,625
127	Stream 0143J	6,072	5,892
125	Unnamed Stream	7,185	7,185
124	Unnamed Stream	10,281 [a]	10,281 [a]
123	Stream 0143H	34,002 [a]	34,006 [a]
122	Stream 0143M	15,317[a]	15,312 [a]
120	Stream 0143G	7,913	8,382
119	Stream 0143F	6,529	6,529
118	Stream 0143E	5,848	5,848
117	Stream 0143D	17,171	17,170
116	Stream 0143B	10,981	10,953
114	Unnamed Stream	6,505	7,984
113	Unnamed Stream	11,110	11,119
109	Unnamed Stream	6,534	6,534
107	Wetland 34A	10,786	10,786
105	Unnamed Stream	5,564	5,565
104	Wetland 34A	10,820	10,822
101	Bear Creek	12,166	12,166

[a] This subbasin needs additional analysis to determine the amount of effective impervious area; therefore, for the purposes of this analysis it was assumed that all new impervious surface would be effective.

The Corridor Alternative would also extend or replace a total of 21 culverts on perennial and intermittent streams, which could result in localized increases in scour and erosion (Appendix D Extended Culvert Table). In locations where the culvert extension would reduce the efficiency of sediment transport, long-term local drainage problems are likely. In addition, ditches and pipes may be relocated, existing ditches may be replaced with a pipe and catch basin system, and new outfalls to Lake Sammamish may be needed to fix drainage problems.

The Corridor Alternative would design some of the culverts to improve fish passage on fish bearing streams, and this could reduce existing scour and erosion and benefit the stream. Potential impacts to downstream properties such as flood and sediment deposition would be considered when selecting these locations and designing the new structures.

Table 7-3 Culverts Conveying Streams Extended Under the Corridor and East Alternatives summarizes the locations at which culverts conveying streams would be extended under the Corridor and East A Alternatives; the Continuation of the Interim Use Trail Alternative would not extend any culverts.

Table 7-3. Culverts Conveying Streams Extended Under the Corridor and East Alternatives

Subbasin	Corridor Station	East A Station	Associated Stream	Culvert Extended: Corridor Alternative	Culvert Extended: East A Alternative
172A	145+00	145+00	Unnamed Stream	YES	YES
167A	n.a.	211+15	Many Springs	NO	YES
	211+90	212+20	Many Springs	NO	YES
163A	n.a.	236+50	Stream 0163 Trib	n.a.	YES
	237+45	237+45	Stream 0163	NO	YES
	239+00	239+10	Stream 0163	NO	YES
161A	254+20	254+50	Unnamed Stream	YES	YES
159A	n.a.	288+60	Stream 0162A	n.a.	YES
	287+90	n.a.	Stream 0162A	YES	n.a.
146A	n.a.	363+90	Unnamed Stream	n.a.	YES
144A	n.a.	375+50	Pine Lake Creek	n.a.	YES
143A	381+20	380+60	Stream 0155	YES	YES
139A	421+10	420+90	Zaccuse Creek	YES	YES
138A	n.a.	429+30	Unnamed Stream	n.a.	YES
	429+40	n.a.	Unnamed Stream	YES	n.a.
136A	n.a.	433+40	George Davis Creek	n.a.	YES
	n.a.	435+50	George Davis Creek	n.a.	YES
	n.a.	437+90	George Davis Creek	n.a.	YES
	437+90	n.a.	George Davis Creek	YES	n.a.
	437+94	n.a.	George Davis Creek	YES	n.a.
135A	n.a.	445+75	Unnamed Stream	n.a.	YES
	446+45	n.a.	Unnamed Stream	YES	n.a.
134A	449+50	n.a.	Unnamed Stream	YES	n.a.
132A	452+40	n.a.	Unnamed Stream	YES	n.a.
129A	n.a.	469+00	Stream 0143K	n.a.	YES
	470+50	n.a.	Stream 0143K	YES	n.a.
127A	484+10	483+10	Stream 0143J	YES	YES
125A	489+70	488+90	Unnamed Stream	YES	YES
123A	494+60	493+85	Stream 0143H	YES	YES
	496+20	495+50	Stream 0143H	YES	YES
	499+85	499+00	Stream 0143H	YES	YES
122A	507+55	506+55	Stream 0143M	YES	YES
119A	525+10	524+25	Stream 0143F	YES	YES
118A	530+80	530+00	Stream 0143E	YES	YES
116A	n.a.	555+40	Stream 0143B	n.a.	YES
109A	593+90	593+10	Unnamed Stream	YES	YES
Total				**21**	**29**

Note: n.a. = not applicable

7.6 EAST A ALTERNATIVE

The East A Alternative would create a linear ribbon of new impervious surface along the length of the project corridor. The East A Alternative would create approximately 22.4 acres of new impervious surface along the trail corridor, 15.7 acres of which would likely be effective impervious surface. Under this alternative, more than 5,000 square feet of new impervious surface would be created in 43 subbasins (see Table 7-2 Subbasins with More than 5,000 ft^2 of New Effective Impervious Areas Draining to Streams of Wetlands; Appendix C Total and Effective Impervious Surface Areas).

The East A Alternative would provide stormwater management of the subbasins in accordance with applicable surface water standards, which would minimize the potential impacts to the environment caused by increases in impervious surface area.

The East A Alternative would also extend or replace a total of 29 culverts associated with perennial and intermittent streams, which could result in localized increases in scour and erosion (Appendix C Total and Effective Impervious Surface Areas). In locations where the culvert extension would reduce the efficiency of sediment transport, long-term local drainage problems are likely. It is possible that some of the culverts would be designed to improve fish passage, and this could reduce existing scour and erosion and benefit the stream. In addition, ditches and pipes may be relocated, existing ditches may be replaced with a pipe and catch basin system, and new outfalls to Lake Sammamish may be needed to fix drainage problems. Table 7-3 Culverts Conveying Streams Extended Under the Corridor and East Alternatives summarizes the locations at which culvert extensions of streams in the Corridor and East A Alternatives would differ.

7.7 EAST B ALTERNATIVE

The East B Alternative would have the same operational impacts as those discussed under the East A Alternative because they are located along the same alignment, would create the same amount of new impervious surface and would extend the same culverts.

7.8 SIGNIFICANT IMPACTS

No significant impacts to surface water resources have been identified through this analysis. It is likely that stream and drainage conditions would improve in the immediate vicinity of the trail in locations where existing culverts would be replaced with properly functioning culverts.

8. INDIRECT AND CUMULATIVE IMPACTS

Secondary impacts are impacts that could result from the incremental effect of the proposed action when added to other past, present, or future projects. Cumulative impacts are impacts that could result when relatively minor independent impacts from multiple projects become collectively substantial over time if not properly mitigated.

The water resources located within the project corridor have already been impacted by past actions such as clearing old growth and second growth forest, developing agricultural lands and, more recently, the development of these areas for residential, commercial, and transportation uses. Most of this development has occurred without environmental mitigation and has contributed to cumulative increases in impervious surfaces which results in increased runoff; increased surface water pollution; decreased infiltration; and changes in stream courses and loss of riparian buffers. However, the proposed build alternatives would not likely have additional cumulative or secondary impacts because current stormwater management requirements would reduce the potential cumulative impacts associated with development, including development of the proposed trail.

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9. MITIGATION

Stormwater management, including detention and treatment, would be provided in accordance with the applicable regulations. Subbasins in which an alternative would create more than 5,000 square feet of new impervious surface were assumed to require some level of stormwater management, such as dispersion, detention, or infiltration. However, because the existing conditions along the project corridor are variable and no survey data has been collected, no specific stormwater management options were identified. The feasibility of stormwater management was evaluated for the ancillary facilities and locations where stormwater management would be difficult were identified.

9.1 OPERATIONAL MITIGATION

Subbasins in which an alternative would create more than 5,000 square feet of new impervious surface were assumed to require some level of stormwater management. Stormwater management was also evaluated for the parking areas and restrooms. In compliance with local permitting requirements, the management of stormwater runoff, such as dispersion, detention, biofiltration, retention, and/or treatment, will be included in all of the Build Alternatives.[5] Because stormwater management minimizes and or prevents impacts associated with runoff, no other long-term mitigation would be required. Details of the stormwater system would be addressed during final design and permitting for the trail. For those locations where culverts would be replaced to improve fish passage and downstream property impacts could occur, the downstream drainage system may be improved.

Some low-impact design techniques such as the use of pervious pavers may be used to reduce potential impacts associated with new impervious surface. BMPs for maintenance operations developed for the interim trail would likely be applied to the Master Plan Trail. These BMPs are documented in the *East Lake Sammamish Interim Use Trail and Resource Protection Plan Final EIS* (King County 2000).

9.2 CONSTRUCTION MITIGATION

All of the Build Alternatives would disturb soils, possibly resulting in turbid stormwater runoff. Stormwater runoff from active construction sites would be treated with BMPs prior to discharge as necessary to comply with the requirements of the WAC and/or the construction NPDES permit. In addition, turbid or contaminated dewatering water would be treated prior to discharge as necessary to comply with the requirements of the Washington Administrative Code and/or the construction NPDES permit, or the local grading permit. During the permitting and design processes, a TESC plan, a spill containment and countermeasures plan (SCCP), and a surface water pollution prevention plan (SWPPP) would be developed for the project. The purpose of these plans is to ensure that pollutants (including sediment) associated with active construction sites and staging areas are controlled and that temporary impacts to water quality are minimized or prevented. Monitoring would be performed in accordance with Ecology's requirements.

9.2.1 Continuation of the Interim Use Trail Alternative

The Continuation of the Interim Use Trail Alternative would not require mitigation.

[5] A list of all permits is provided in Section 2. Regulatory requirement specifically related to water resources are discussed in Section 3.2.3.1.

9.2.2 Corridor Alternative

The Corridor Alternative may require mitigation such as local stream habitat enhancement at locations where stream culverts are extended or replaced.

9.2.3 East A Alternative

The East A Alternative may require mitigation such as local stream habitat enhancement at locations where stream culverts are extended or replaced.

9.2.4 East B Alternative

Mitigation activities would be the same as in the East A Alternative because they would have the same impacts to water resources.

10. REFERENCES

Castelle, A.J., A.W. Johnson, C. Conolly. 1994. Wetland and stream buffer size requirements—a review. Journal of Environmental Quality. Col. 23: 878-882.

Daniels, R.B., J.W. Gilliam, 1996. Sediment and chemical load reduction by grass and riparian filters. Soil Science Society American Journal. 60: 246-251.

Driscoll, E., P.E. Shelley, and E.W. Strecker. 1990. Pollutant loadings and impacts from highway stormwater runoff, Volume III: Analytical investigations and research report. FHWA RD-88-008. Federal Highway Administration. Prepared by Woodward-Clyde Consultants, Oakland, California.

Ecology (Washington State Department of Ecology). 1992. Stormwater Management Manual for Puget Sound Lowlands. Washington State Department of Ecology. Olympia, WA.

Ecology (Washington State Department of Ecology). 1994. East Lake Sammamish Basin-watershed Management Committee Basin and Nonpoint Action Plan. Washington State Department of Ecology. Olympia, Washington.

Ecology (Washington State Department of Ecology). 2001. Stormwater management manual for Western Washington. Publication # 99-11 through 99-15. Prepared by the Washington State Department of Ecology, Water Quality Program. August 2001.

Ecology (Washington State Department of Ecology). 2004. Draft 2004 Washington State's Water Quality Assessment - 303(d) List of Threatened and Impaired Water Bodies: WRIA 08 Cedar-Sammamish. Washington State Department of Ecology. Bellevue, Washington.

FEMA (Federal Emergency Management Agency). 1995. Flood Insurance Rate Map, King County, Washington and Incorporated Areas. [53033C0680 F, 53033C0687 F, and 53033C0685 F]. Washington D.C.

FEMA (Federal Emergency Management Agency). 1998. Flood Insurance Rate Map, King County, Washington and Incorporated Areas [553033C0691 F, 553033C0380 F]. Washington D.C.

FHWA (Federal Highway Administration) and WSDOT (Washington State Department of Transportation). 2002. NEPA Environmental Assessment: East Lake Sammamish Interim Use Trail and Resource Protection Plan. Prepared by Adolfson Associates, Inc.; Parametrix, Inc.; and Associated Firms. Washington State Department of Ecology. Bellevue, Washington. May 2002.

Issaquah, City of. 1995, amended 1997. Final Comprehensive Plan. City of Issaquah Planning Department, Issaquah, Washington.

Issaquah, City of. 2002. City of Issaquah comprehensive plan. Adopted 1995. Amended 2001 and 2002. City of Issaquah Planning Department.

Johnson, A.W. and D.M. Ryba. 1992. A literature review of recommended buffer widths to maintain various functions of stream riparian areas. King County Surface Water Management Division.

King County. 1990a. Proposed Bear Creek basin plan. King County Department of Public Works, Surface Water Management Division. Seattle, Washington. 117 pp.

King County. 1990b. East Lake Sammamish Basin Conditions Report—Preliminary Analysis. King County Department of Public Works, Surface Water Management Division. Seattle, Washington. 148 pp and Appendices.

King County. 1993. Sammamish River Corridor Conditions and Enhancement Opportunities. King County Surface Water Management Division. Seattle, Washington.

King County. 1994a. East Lake Sammamish Basin: Watershed Management Committee: Basin and Nonpoint Action Plan. King County Surface Water Management Division and Washington State Department of Ecology. Seattle, Washington.

King County. 1994b. Issaquah Creek Watershed Management Committee Proposed Basin and Nonpoint Action Plan. King County Department of Public Works and Issaquah/East Lake Sammamish Watershed Management Committee. Seattle, Washington.

King County. 1994c. King County Comprehensive Plan. King County Department of Development and Environmental Services. Seattle, Washington.

King County. 1994d. East Lake Sammamish Basin and Nonpoint Action Plan: Annual Report 1994 Water Year. King County Surface Water Management Division. Seattle, Washington.

King County. 1995. Lake Sammamish Total Phosphorus Model. King County Department of Metropolitan Services; Water Pollution Control Department and King County Surface Water Management Division. Seattle, Washington.

King County. 1998a. King County Surface Water Design Manual. King County Department of Natural Resources. Seattle, Washington.

King County. 1998b. Lake Sammamish Water Quality Management Project Final Report. King County Department of Natural Resources. Seattle, Washington.

King County. 1999a. East Lake Sammamish Trail Interim Use and Resource Protection Plan. August 27, 1999 Draft Report, Appendix A: Wetland, Stream Drainage, and Floodplain Report. King County Park System and Department of Construction and Facilities Management. Seattle, Washington.

King County. 1999b. East Lake Sammamish Trail Interim Use and Resource Protection Plan, 7-28-99 Draft Report. King County Park System and Department of Construction and Facilities Management. Seattle, Washington.

King County. 1999c. Lake Sammamish Water Quality, Management Project. King County Department of Natural Resources Website: www.splash.metrokc.gov/wrl/waterres/lakes/SAMM.htm. Accessed December 27, 1999.

King County. 1999d. Drainage Complaint Database Query. King County Water and Land Resources Division: Drainage Services Section. Accessed 1999. Seattle, Washington.

King County. 1999e. Draft King County Year 2000 Comprehensive Plan Update. King County Office of Regional Planning. Seattle, Washington.

King County. 1999f. King County Annual Growth Report. King County Office of Regional Planning. Seattle, Washington.

King County. 1999g. King County Zoning Atlas. Ordinance 13672, December 16, 1999.

King County. 2000. East Lake Sammamish Interim Use Trail and Resource Protection Plan Final EIS. King County Department of Construction and Facilities Management. Seattle, Washington.

King County. 2003a. http://dnr.metrokc.gov/swd/resrecy/composting/manure.htm. Accessed December 17, 2003.

King County. 2003b. http://dnr.metrokc.gov/wlr/waterres/streams/samsedindex.htm#abstract. Accessed December 17, 2003.

King County. 2004a. East Lake Sammamish Master Plan Trail Draft Environmental Impact Statement. King County Park System and Department of Construction and Facilities Management. Seattle, Washington.

King County. 2004b. East Lake Sammamish Master Plan Trail: Wetland Biology Discipline Report. King County Park System and Department of Construction and Facilities Management. Seattle, Washington.

Lowrance, R., R. Leonard, and J. Sheridan. 1985. Managing riparian ecosystems to control nonpoint pollution. Journal of Soil and Water Conservation. Jan-Feb 1985.

Lowrance, R., R. Todd, J. Fail, Jr., O. Hendrickson Jr., R. Leonard, and L. Asmussen. 1984. Riparian forests as nutrient filters in agricultural watersheds. Bioscience Vol. 34 No. 6: 374-377.

Metro. (Municipality of Metropolitan Seattle). 1987. Lake Sammamish Water Quality Management Project: Technical Report. Entranco Engineers. Seattle, Washington.

NOAA (National Oceanic and Atmospheric Administration). 2003. Climate at a Glance: Annual Precipitation, Seattle Washington, 1945 to 2002. http://climvis.ncdc.noaa.gov/cgi-bin/cag3/hr_display3.pl

Osborne, L.L., and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. Freshwater Biology. V29:243-258.

Redmond, City of. 1997a. Sensitive Areas Chapter 20D.140. Redmond Community Development Guide.

Redmond, City of. 1997b. Redmond Community Development Guide. City of Redmond, Redmond, Washington.

Redmond, City of. 1997c. City of Redmond Comprehensive Plan. City of Redmond, Redmond Washington.

Redmond, City of. 1999. Stormwater Management and Erosion Control Technical Notebook. Issue Number 3. City of Redmond Stormwater Engineering Services Division.

Salo, E.O. and T.W. Cundy (editors). 1987. Streamside management: forestry and fishery interactions. University of Washington Institute of Forest Resources, Contribution 57.

Sammamish, City of. 1999. Interim Sammamish Development Code. City of Sammamish, Sammamish, Washington.

Sammamish, City of. 2004. City of Sammamish, Ordinance No. O2004-135, dated January 8, 2004. Sammamish, Washington.

Swinkler, A.M. and J.G. Davies. 2003. Horse Manure Management. Colorado State University Cooperative Extension Publication Number 1.219. Accessed at: http://www.ext.colostate.edu /pubs/livestk/01219.html.

Whipple, Jr. W., J.M. DiLouie, and T. Pytlar Jr. 1981. Erosional potential of streams in urbanizing areas. Water Resources Bulletin, American Water Resources Association. Vol. 17. No. 1.

Williams, R.W., R. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization, Volume 1, Puget Sound. Washington Department of Fisheries.

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APPENDIX A

Project Corridor Subbasin Maps

APPENDIX B

Project Corridor Stream and Culvert Table

APPENDIX C

Total and Effective Impervious Surface Areas

APPENDIX D

Extended Culvert Table

APPENDIX E

Ancillary Facility Stormwater Management Feasibility